Bonneville Power Administration
Fish and Wildlife Program FY99 Proposal Form

How this form is structured

There are ten major sections to this form. Sections 1 through 5 are database-style fields in which specific information is being sought, so your input is restricted to the gray boxes below. *The boxes are pointers to indicate where to type; they will grow as you type more text, and they won't print as gray boxes.* These sections include: General Administrative Information; Key Words; Objectives, Tasks and Schedules; Relationship to Other Bonneville Projects; and Budget.

In Sections 1 through 5, each field is briefly described on the form itself, and for some fields more tips are shown in the status bar (bottom of the screen). For tables where more rows may be needed than are provided, press Alt-R from within the table to add a row at the end.

Sections 6 through 10 accept a narrative format in which more open-ended questions are asked and you may respond at length in paragraph form. Descriptions are provided on the form. These sections include: Abstract, Description, Relationships to Other Projects, Personnel, Information/Technology Transfer.

Steps to complete the form

1. First, read the Guidelines to Proposals.
2. Second, save this form. For ongoing projects, use your project number.DOC (example: 8909900.DOC). For new proposals, use a filename other than BLANK.DOC, preferrably your agency acronym and your initials (example: NMFSWS1.DOC).
3. Press Tab to move to the first field (Title of Project), and start typing.
   NOTE: When you exit the Project Title or Project Number fields, your screen may display a "Header" box briefly. The form is updating itself, and will continue normally.
4. Fill in all fields (gray boxes) pressing Tab to advance from one field to the next. Then fill in narrative input areas, pressing down arrow to advance.
5. Print the completed document.
6. Save the document to diskette and mail both paper and diskette to:
   Bonneville Power Administration - EW
   ATTN: Connie Little
   FY99 Proposals
   P.O. Box 3621
   Portland OR 97208-3621

Call Jim Middaugh at the Northwest Power Planning Council (503) 222-5161 or (800) 222-3355 or email middaugh@nwppc.org if you have additional questions.

Proposals must be received to Bonneville by 5pm PST on Friday, January 23, 1998. Late proposals will not be reviewed for FY99 funding. This information will be the only material submitted for independent scientific review. It is essential that the relevant information be provided completely but concisely.

Section 1. General administrative information

Title of project. 75 characters or less; do not include the contractor name or acronym; use abbreviations if appropriate; start with action verbs, i.e., "Evaluate Coho...", not "Evaluation of Coho".

Determine Salmonid Carrying Capacity In Watersheds By Flir Remote Imagery

Bonneville project number, if an ongoing project ________

Business name of agency, institution or organization requesting funding
Departments of Wildlife and Fisheries and Forest Sciences, Oregon State University

Business acronym (if appropriate) O.S.U.

Proposal contact person or principal investigator:

Name Hiram W. Li And Bruce A. Mcintosh
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City, ST Zip Corvallis Oregon 97331-3803 And 97331
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Subcontractors. List other agencies or entities that will receive funding under this project, either through sub-contracts managed by the project sponsor or, where multiple agencies are involved as joint sponsors, through primary contracts managed by Bonneville. If another entity will be responsible for the long term maintenance of the project, identify them here.

List one subcontractor per row; to add more rows, press Alt-R from within this table

Organization	Mailing Address	City, ST Zip	Contact Name
Snowy Butte Helicopters		Medford, OR	Karen Gunther

NPPC Program Measure Number(s) which this project addresses. Refer to 1994 Fish and Wildlife Program as amended in 1995; NPPC staff will proof this field and correct if necessary; separate multiple measure numbers with commas.
Measure 205-Coordinated Implementation, Monitoring and Evaluation

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NMFS Biological Opinion Number(s) which this project addresses. If the project relates to the Kootenai Sturgeon Biological Opinion, the NMFS Hydrosystem Operations Biological Opinion, or other Endangered Species Act requirements, enter the Action Number and Biological Opinion Title.
LRMP Biological Opinion for ESU spring/summer chinook salmon

Other planning document references. If the project is called for in the National Marine Fisheries Service *Snake River Salmon Recovery Plan*, or in *Wy Kan Ush Me Wa Kush Wit*, the Anadromous Fish Restoration Plan of the Nez Perce, Umatilla, Warm Springs and Yakama tribes, in U.S. Forest Service or Bureau of Reclamation land management plans, or in local area subbasin or watershed plans, or in other planning documents, provide the name of the plan and reference citation where the need is identified.

If the project type is “Watershed” (see Section 2), reference any demonstrable support from affected agencies, tribes, local watershed groups, and public and/or private landowners, and cite available documentation.
ODFW (Tim Unterwegner, Jeff Zakel), U.S. Forest Service (Phil Howell, Christine Hirsch), Confederated Tribes of Warm Springs (Mark Fritsch)

Subbasin. List subbasin(s) where work is performed. Use commas to separate multiple subbasins. Coordination projects or those not affecting particular subbasins may omit this field.
North Fork, Middle Fork, and Upper Mainstem John Day rivers and the Grande Ronde Watershed

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Short description. Describe the project in a short phrase (less than 250 characters). Give information that is not in the title. If possible start this field with an action verb (protect, modify, develop, enhance, etc.) rather than a noun (this project protects). There is room for a more detailed project abstract later in the narrative section, so please keep this answer short.
Accurate indices of watershed carrying capacities for anadromous salmonids using remote sensing and GIS technologies will be a tremendous boon for testing detecting limiting factors, and planning for and monitoring stream rehabilitation projects.

Section 2. Key words

For identifying and sorting, mark key words below that most specifically describe this project. Under each heading (Programmatic Categories, Activities, Project Types), find the **one** item that most applies to your project, and mark it with an X in the Mark column. If other items in the same heading also apply, mark them with a plus sign or asterisk.

Mark	Programmatic Categories	Mark	Activities	Mark	Project Types
X	Anadromous fish		Construction	X	Watershed
X	Resident fish		O & M		Biodiversity/genetics
	Wildlife		Production		Population dynamics
	Oceans/estuaries	X	Research	X	Ecosystems
	Climate	X	Monitoring/eval.	X	Flow/survival
	Other		Resource mgmt		Fish disease
			Planning/admin.		Supplementation
			Enforcement		Wildlife habitat enhancement/restoration
			Acquisitions		

Other keywords. If there are other key words that would help identify your project, enter them below, separated by commas; example key words: DNA, stock identification, life history, sampling, modeling, nutrient dynamics, predation, hydrodynamics, gas bubble disease, disease names, hatchery-wild interactions, ecological interactions.
Watershed carrying capacity, temperature, limiting factors, FLIR, remote sensing, spring chinook salmon, dam mortality, ecosystem assessment,

Section 3. Relationships to other Bonneville projects

Describe any interdependencies with other projects funded under the Fish and Wildlife Program. Don't include general relationships to other projects, but target those that depend on this project being funded, or vice versa. There is room in Section 7 below to comment on other relationships or to describe these more fully.

If you need more rows, press Alt-R from within this table.

Project #	Project title/description	Nature of relationship
5519100	Evaluate Meadow Creek Instream Structure and Riparian Restoration	This is a complementary study that gets at the mechanisms which generates the landscape signals we detect. Meadow Creek is a tributary of the Grande Ronde River.
9008000	Columbia Basin PIT Tag Information Systemi	We will need pit tag information to calibrate the smolt migration and survival model for the migration of smolts from the Grande Ronde to Bonneville Dam.
0	Hydrologic, geomorphic and ecological connectivity of Columbia River Basins	Our EPA/NSF funded study which has provided us the support to develop the ecological basis for this proposal.

Section 4. Objectives, tasks and schedules

This section has three parts: a) Objectives and tasks table, b) Objective schedules and costs table, c) other schedule fields. Instructions for each part follow the headings.

Objectives and tasks

Briefly describe measurable objectives and the tasks needed to complete each objective. Use Column 1 to assign numbers to objectives (for reference in the next table), and Column 3 to assign letters to tasks. Use Columns 2 and 4 for the descriptive text. Objectives do not need to be listed in any particular order, and need only be listed once, even if there are multiple tasks for a single objective. List only one task per row; if you need more rows, press Alt-R from within this table.

Obj 1,2,3	Objective	Task a,b,c	Task
1	Determine whether the Grande Ronde Basin greater potential carrying capacity for spring chinook salmon than the John Day Basin	a	CollectThermal imagery from each watershed by collecting FLIR video from helicopters.
		b	Collect images of the physical structure of stream channels, and the quantity, quality, and distribution of riparian vegetation of each channel. using true-color, geo-referenced, video from helicopters
		c	Thermally map watershed imagery through (1) temperature classification of pixels, (2) Form digital mosaics of images to store in ArcInfo as GIS layers.
		d	Convert true-color videos into digital mosaic images to use as GIS layers in ArcInfo
		e	Use ArcInfo software to quantify different indexes of carrying capacity of each drainage.
		f	Ground truth imagery using snorkeling census techniques to survey fish densities, hobo temp mentors to verify temperatures at known locations, FSL data base to verify stream channel structure characteristics, verify classification

			of riparian vegetation.
		g	Test hypothesis for statistical significance
2	Determine whether cumulative mortality of downstream migrating smolts to Bonneville Dam is higher for Grande Ronde spring chinooks than for those of the John Day.	a	Simulate survival using Danny Lee's smolt survival model (USFS, FSL Boise)
		b	Verify model by examining results of pit-tagging studies from different release sites in the Columbia River
0			Examine results from model output. Determine if experimental releases of pit-tagged hatchery smolts should be planned or whether output is sufficiently compelling
3	Use decision tree to draw final conclusions	a	Analyse and synthese information to determine outcome of study.

Objective schedules and costs

Partition overhead, administrative, support, and any other common costs shared among objectives. The percentages for all objectives should total 100%. Enter just the objective numbers from Column 1 in the above table. Enter start and end dates for each objective using the mm/yyyy format (e.g. 05/2002 for May, 2002).

If you need more rows, press Alt-R. **Press Alt-C to calculate total.**

Objective #	**Start Date mm/yyyy**	**End Date mm/yyyy**	**Cost %**
1	6/1998	6/2000	50.00%
2	6/1998	6/2000	30
3	6/2000	6/2001	2000.00%
			TOTAL 0.00%

Schedule constraints. Identify any constraints that may cause schedule changes. Describe major milestones if necessary.

Completion date. Enter the last year that the project is expected to require funding.
2001

Section 5. Budget

This section has two tables: 1) FY99 budget by line item, and 2) Outyear costs. Instructions for each part follow the heading.

FY99 budget by line item

List FY99 budget amounts for each category. If an item needs more explanation, provide it in the Note column. If project uses PIT tags, include the cost ($2.90/tag). **Press Alt-C to calculate total.**

Item	**Note**	**FY99**
Personnel		$45,571
Fringe benefits		$12,238
Supplies, materials, non-expendable property		$2,000
Operations & maintenance		
Capital acquisitions or improvements (e.g. land, buildings, major equip.)		
PIT tags	# of tags:	
Travel		$5,000
Indirect costs		$39,231
Subcontracts	collect FLIR imagery	$55,000
Other	tuition	6623
TOTAL		$165,663

Outyear costs

List budget amounts for the next four years, and the estimated percentage of those costs for operations and maintenance (O&M).

Outyear costs	**FY2000**	**FY01**	**FY02**	**FY03**
Total budget	$173,453	$182,045		
O&M as % of total	0.00%	0.00%		

Section 6. Abstract

A condensed description to briefly convey to other fish and wildlife scientists, managers and non-specialists the background, objectives, approach and expected results. **In under 250 words,** include the following:

a. Specific items in any solicitation being addressed
b. Overall project goals and objectives
c. Relevance to the 1994 Columbia Basin Fish and Wildlife Program (benefit to fish and wildlife)
d. Methods or approach based on sound scientific principles

e. Expected outcome and time frame
f. How results will be monitored and evaluated

We propose a novel approach to determine carrying capacities of watersheds for anadromous salmonids using remotely detected indices of stream temperature, channel condition and condition of riparian vegetation. Preliminary results of this approach are very promising. We intend to verify this technique while simultaneously determining whether watershed quality or dam passage mortality are limiting factors for the endangered spring chinook salmon of the Grande Ronde Basin. Development of this technique will enable managers to quickly inventory the relative status and conditions of watersheds. Among the benefits is the possibility of determining whether or not the watershed is underseeded. This method will be much faster and cheaper than the Hankin and Reeves method now employed and will cover a larger landscape than presently possible. We believe the method will provide accurate although crude estimates of relative carrying capacity. The central idea is that we can determine quantities of acceptable habitat by using information on physiological limits of fishes and habitat preferences. Detecting the signals affecting these factors is the role of remote sensing. GIS software enables us to quantify the habitat that is acceptable and unacceptable in each basin. We ground truth the imagery and develop calibration curves for our work. We use standard statistical methods to determine significance. We believe that the importance of this work for monitoring and developing programs for watershed restoration is self evident.

Section 7. Project description

This full description of the project should be in sufficient detail to include the following information under headings a through g **(maximum of 10 pages for entire project description)**:

a. Technical and/or scientific background. The overall problem should be clearly identified with background history and scientific literature review, if a research project. Location should be specific, if relevant. Goals and objectives of the 1994 Fish and Wildlife Program (FWP), NMFS Biological Opinion, or other plans in relation to the proposed project should be stated and described in some detail. Indicate whether the project mitigates losses in place, in kind, or if out-of-kind mitigation is being proposed.

Show how the proposed work is a logical component of an overall conceptual framework or model that integrated knowledge of the problem. The most significant previous work history related to the project, including work of key project personnel on any past or current work similar to the proposal, should be reviewed. All work should be adequately referenced and listed at the end of this field.

Our past research that we can quickly gather baseline data to index carrying capacity of watersheds for salmonids in the John Day Basin using remote sensing and GIS technology. We developed this approach through EPA/NSF National Watershed Competition *(“Hydrologic, Geomorphic and Ecological Connectivity in Columbia River Watersheds: Implications for Endangered Salmonids”)* We foresee that this type of information can be used to assess priorities rapidly for habitat restoration and fisheries management. We also suggest that additional light can be shed on one of the most controversial management issues in the Columbia River basin. The relative role of dam impacts vs. watershed conditions on the decline of salmon has been the subject of one of the more contentious debates for the past 30 years. This is because a direct experimental test is nearly intractable. However, we suggest that we can test the relative roles indirectly, using remotely sensed indicators of watershed health and analyzing pit tagging data from experiments, some of which are being presently conducted.

Ideally, the tests should be conducted on similar watersheds within the same ecoregion; however intensity of land use may differ leading to potential differences in watershed health. Moreover in the ideal test case, migrating salmon should be forced to negotiate more dams through the migratory phases of life history to one watershed than the other. We believe that we have two such candidate watersheds in the Blue Mountain Ecoregion: the John Day basin vs. the Grande Ronde basin. The two watersheds literally are on opposite sides of the same mountain. The John Day basin supports one of the strongest runs of wild spring chinook salmon in the Columbia Drainage, with escapements ranging from 1,000-2,500 annually (Oregon Water Resources Department 1986). Wild spring chinook are a federally listed endangered species in the Grand Ronde and escapement in recent years have been measured in hundreds rather than in thousands (Jeff Zakel, Personal Communication).

What might account for these differences? One explanation may be that a migrating spring chinook salmon must negotiate 8 dams to and from the Grand Ronde Basin to the Pacific Ocean; in comparison, spring chinook salmon of the John Day Basin are only confronted with 3 dams. This begs the question, what are the relative conditions of the respective watersheds? Each contains two wilderness drainages, each is used to produce livestock and timber. Impacts on riparian zones by natural and human disturbances are similar (Table 1).

Table 1. Disturbance factors on riparian zones. Modified from Hanson (1987)

Basin	Grazing	Logging	Roads	Channelized Stream	Floods	Irrigation	Minin g	Agriculture
John Day	X	X	X	X	X	X	X	X
Grande Ronde	X	X	X	X	X	X	X	X

The John Day system is about 7X larger than that of the Grande Ronde, but historical limits for rearing area for chinook salmon were similar. Arguably, the Grande Ronde watershed is in better shape than the John Day , because bull trout (*Salvelinus confluentus)* are rare in the John Day basin (Ratliff and Howell 1992); whereas, three of the eight bull trout strongholds on the eastside are subbasins of the Grande Ronde drainage. Bull trout are resident salmonids and demand the highest water quality and complex habitat conditions (Howell and Buchanan 1992). This should have high carryover for chinook spawning and rearing habitat.

Remotely sensed indicators of habitat quality and salmonid carrying capacity: Much of this proposal depends upon how well our remotely sensed imagery detects and indicates habitat quality. During the past four years we have used the combination of imagery from forward-looking infrared (FLIR) and true-color videography and radio tracking techniques to examine habitat selection by adult spring chinook salmon in the John Day basin. We captured FLIR and true-color images over expanses of stream up to 70 km in length within each drainage and tracked radio-tagged, migrating salmon up to 300 km of river reach (Figure 1). Fish were followed for 8-12 weeks and supplemental observations were conducted using snorkeling techniques.

The results of our previous research suggest that stream temperature is a good index for salmonid carrying capacity in watersheds east of the Cascade Mountains because of its physiological affects on fish (Li et al. 1994), and affects on the trophic dynamics and food web structure of trout/salmon streams (Tait et al. 1994). We found that adult spring chinook salmon elected to hold in coldwater refugia and deep pools ($P < 0.01$) in the warmer, managed stream (Middle Fork John Day) where the Upper Incipient Lethal Temperature was often exceeded during the base flow period; whereas, temperature selection in the cooler wilderness stream (North Fork John Day) was weak, $P < 0.30$ (Torgersen 1996; Torgersen et al., manuscript submitted). Adult spring chinook in the more pristine North Fork John Day also used more types of habitat units to hold before spawning (Figures 2, 3). Stream capacity of the North Fork John Day was 35 salmon km^{-1} or nearly double that of the Middle Fork John Day, 18 salmon km^{-1} (Torgersen 1996).

The down stream range of both juvenile and adult spring chinook salmon was delimited by lethal thermal boundaries.

Preliminary investigations suggest that the availability of pool habitats (quantity and quality) along with thermal conditions may provide powerful indices of the relative carrying capacity of watersheds for salmonids in the arid eastside of eastern Oregon and Washington. We found that we could accurately capture temperature patterns across scales, from watersheds to habitat units using FLIR. The r^2 between our remotely sensed temperatures and our ground sensors was 0.93. Longitudinal temperature patterns were markedly different between the different streams. The wilderness stream of the North Fork John Day exhibited the “normative” pattern of gradual warming downstream (Figure 4); whereas the more disturbed watershed, the Middle Fork John Day, was characterized by a series of alternating peaks and troughs of warming and cooling among reaches (Figure 5). Maximum temperature differences between peaks and troughs were in the order of 4-5^{o}C. Interestingly, the shape of the longitudinal profile remained remarkably similar from year to year (Figures 4, 5). The temperature profiles appear to move up and down the y-axis, although the amplitude from peak to trough appears to be reduced during warm years. We interpret this to mean that the causes of thermal patterns are constant from year to year although the degree of expression may vary. The degree to which a stream is thermally patchy may be an indication of anthropogenic disturbances.

By using biologically defined temperature standards as indicators. we can document the relative differences among watersheds to support spring chinook salmon on the eastside We can use GIS technology to quantify the percentage and amount of stream area that fall into temperature patches. For example, none of the stream habitats in the Middle Fork John Day meet Oregon’s state mandated water quality standard in 1994 whereas 4% was available in this temperature category for the North Fork John Day (Figure 6). Only 2.6 % of the habitat in the Middle Fork was in the class of physiologically tolerable temperatures, in contrast to the 64% habitat available in the North Fork John Day (Figure 6).

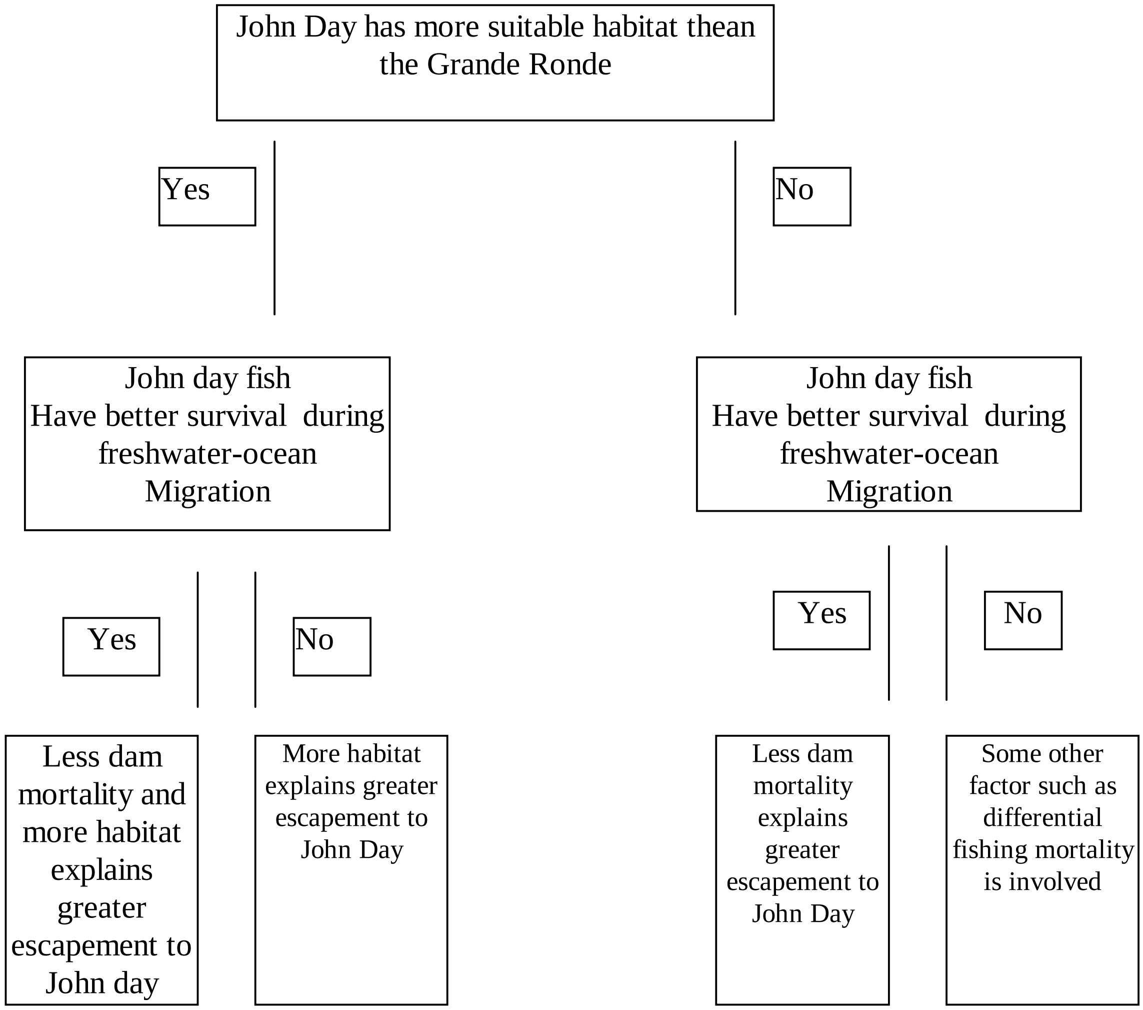
Other indices of habitat quality can be detected using remote sensing via true-color videography. It is generally accepted that complex stream channels as measured by stream sinuosity, frequency of large pools, and volume of large woody debris are beneficial for fish and it is also generally accepted that complex habitats are associated with large expanses of intact riparian vegetation. We will measure and quantify these factors as independent ways to index the carrying capacity of streams.

b. Proposal objectives. Specific, measurable objectives or outcomes for the project should be presented concisely in a numbered list. Research proposals must concisely state the hypotheses and assumptions necessary to test these. Non-scientific projects must also state their objectives. Clearly identify any products (reports, structures, etc.) that would result from this project. For example, an artificial production program may state the species composition and numbers to be produced, their expected survival rates, and projected benefits to the FWP. A land acquisition proposal may state the conservation objectives and value of the property, the expected benefits to the FWP, and a measurable goal in terms of production. Methods and tasks (in heading e, below) are to be linked to these objectives and outcomes (by number).

Test the following working hypothesis: The difference in escapement of spring chinook salmon between the John Day and Grande Ronde watersheds is due to cumulative negative impacts of 8 dams vs. 3 dams upon migrating spring chinook salmon and the Grande Ronde basin is in better condition than the John Day basin.

Specifically the following null hypotheses will be tested:
1. Habitat quality in the John Day basin is similar to that of the Grande Ronde
2. There is no difference in mortality rate of smolts migrating to Bonneville Dam by smolts from either drainage.

Decision Tree



c. Rationale and significance to Regional Programs. The rationale behind the proposed project should be presented and project objectives and hypotheses related as specifically as possible to the FWP objectives and measures or to other plans. You should make a convincing case for how the proposed work will further goals of the FWP. Relevant projects in progress in the Columbia Basin and elsewhere should be listed and discussed in relation to the proposed project. Arrangements should be identified and documented for cooperation and synergistic relationships among the proposed project, *other project proposals,* and existing projects. Any particularly novel ideas or contributions offered by the proposed project should be highlighted and discussed.

We will develop a method to index carrying capacity of watersheds for salmonid fishes using a rapid, cost-effective, remote sensing technology. This type of tool can be used to quickly inventory landscapes, thereby significantly reducing the amount of time needed to assess habitat quality over the eastside of the Columbia Basin. The information derived from this project would help managers prioritize and allocate funds for restoration needs over the watershed. We intend to test this method as a monitoring technique either to document present problems or to monitor progress in terms of restoration and a means of testing hypotheses concerning critical habitat problems in the Columbia Basin. We see as its second use, a means to test management policies over appropriate spatial scales. Too many of our research and monitoring is site specific and it is clear that we need to take an ecosystem perspective of the complex problems on the Columbia River.

d. Project history (for continuing projects). If the project is continuing from a previous year, the history must be provided. This includes projects that historically began as a different numbered projects (identify number *and short title*). For continuing projects, the proposal primarily will be an update of this section. List the following:

- project numbers (if changed)
- project reports and technical papers
- summary of major results achieved
- adaptive management implications
- years underway (see attached spreadsheet)
- past costs (see attached spreadsheet)

Not applicable

e. Methods. How the project is to be carried out based on sound scientific principles should be described (this is applicable to all types of projects). Include scope, approach, and detailed methodology. If methods are described in detail in another document, summarize here and cite reference. The methods should include, as appropriate, but not be limited to such items as:

- tasks associated specifically with objectives
- critical assumptions
- description of proposed studies, experiments, treatments or operations in the sequence that they are to be carried out
- any special animal care or environmental protection requirements
- any risks to habitats, other organisms, or humans
- justification of the sample size
- methods by which the data will be analyzed
- methods for monitoring and evaluating results
- kinds of results expected

Each proposer should complete the methods section with an objective assessment of factors that may limit success of the project and/or critical linkages of the proposal with other work (e.g., a smolt monitoring program, etc.).

1. Testing for Differences in Basin Carrying Capacity. Our FLIR videography will be used to thermally map watersheds and the true-color videography will provide data to characterize the physical properties of the stream channel and the condition, extent and density of the riparian vegetation.

Thermal mapping: FLIR videography provides a continuous thermal map that we can convert to a mosaic composite using frame-grabbing software and store as a GIS file in ArcInfo™. HoboTemp™ digital data loggers will be placed at point locations to "ground truth" the imagery. Thermal mapping using low altitude FLIR will be collected during peak summer temperatures during the first week of August. Imagery will be collected between 15:00 and 16:00 h to capture peak daily water temperatures. Thermal imagery in the 8-12µm wave band will be collected with an AGEMA Thermovision® FLIR camera from a helicopter flying 40 cm/h at 300 m above the river surface. Elevation above the surface will be controlled with reference to a laser altimeter. With a 20 degree field of view and an image size of 140 x 140 pixels we can collect imagery with ground resolutions ranging from 20-40 cm. Analog data will be calibrated in degrees C, digitized and stored during flight at a rate greater than 3 frames/second on the hard drive of a personal computer. Time of day, frame number, and pixel statistics will be stored in header files associated with each digital image. Position fixes for each image will be obtained by relating GPS data acquisition times from a running GPS receiver to image acquisition times in the header files. Post-processing of imagery involves 1) temperature classification from pixel values in degrees C, and 2) subsequent compilation of mosaics forming continuous thermal maps of study reaches.

Indices of Carrying Capacity: We will use ArcInfo® GIS software to obtain from FLIR imagery percentages and absolute amounts of area of stream habitat falling into four temperature classes for spring chinook salmon (Armour 1991): (1) optimal (15.5^{o}C), (2) Oregon mandated stream standard (17.8^{o}C), (3) upper range of tolerance (22^{o}C) and lethal (25^{o}C ✂). G^2 and Kolmogorov-Smirnov tests will be used to determine statistical significance of differences between drainages.

We will "ground truth" temperature patches of different sizes within each drainage to the number of juvenile and adult chinook salmon they support. In essence, these will be calibration curves for each drainage. Analyses of Covariance will be used to test for statistical significance of differences between regressions of fish numbers on patch sizes of each temperature class.

We will determine interannual variability among years within each basin to document variability in carrying capacity as indexed by stream temperature as shown in Figure 7. This variability explains year class success attributable to annual shifts in watershed conditions.

We will gather other indices of habitat quality using true-color videography. We will create mosaics from video frames, geo-reference the imagery, and gather statistics on stream sinuosity, frequency of large pools, and number of large woody debris piles. We will get estimates of the number of pools 1 m deep ✂, substrate embeddedness, and volumes of large woody debris from the combined USFS/ODFW stream survey data base maintained at the USFS-PNW Laboratory at Oregon State University. We will use paired t-tests to determine statistical significance of differences between the two watersheds for each variable. We will also measure the extent and density of riparian vegetation in three classes: wetland vegetation (sedges, bull rushes, etc.), grasses and forbs, and riparian trees and shrubs. We will use paired t-tests to measure quantities and Kolmogorov-Smirnov and G^2 tests to examine for potential differences in percent abundances.

Expected Results: If habitat quality in the John Day > than the Grand Ronde, then greater escapement to the John Day be attributable to habitat alone. If habitat quality of the John Day ✂ than the Grande Ronde, then dam associated mortality may be implicated in smaller escapement to the Grande Ronde.

2. Mortality associated with dams and dam passage. Taking the first cut, we will use salmon survival by dam to estimate survival of smolts given the 8 dams the Grande Ronde smolts must negotiate, in comparison to the 3 dams that the John Day fish encounter. We will use information from pit-tag release and monitoring studies currently being conducted. We are aware of a release study conducted near the Grande Ronde, but no studies near the John Day confluence to the Columbia River. We will work to develop a cooperative effort with ODFW or NMFS to conduct a test release near the forebay of the John Day Dam if our first cut analysis appears promising. We would use the same stock of hatchery fish to conduct the study to control for genetic differences and control for handling via appropriate habituation/holding times to control for handling stress.

We will be cooperating with ODFW District Biologists for the John Day Basin (Tim Unterwegner) and the Grand Ronde Watershed (Jeff Zakel) for estimates of escapement and redd densities during the time of the study. We will enter long term data sets for the Grande Ronde drainage as a GIS data layer. We already have done so for the John Day River.

Expected Results: If total survival rate of migrating John Day spring chinook smolts ✂ spring chinook smolts of the Grande Ronde, then differential mortality imposed by greater numbers of dams for Grande Ronde fish will not explain the low escapement to the Grande Ronde Basin. If total survival rate of John Day spring chinook smolts 🖃 spring chinook smolts of the Grande Ronde, then dams are implicated in escapement differences between catchment basins.

f. Facilities and equipment. All major facilities and equipment to be used in the project should be described in sufficient detail to show adequacy for the job. The proposal should indicate whether there are suitable (based on contemporary standards) field equipment, vehicles, laboratory and office space and equipment, life support systems for organisms, and computers, for example. Any special or high-cost equipment to be purchased with project funds should be identified and justified. Reference to other proposals is allowed but note that limitations of those proposals could effect the evaluation of the ones citing them.

Computers: 10 Pentium PC personal computers, 2 McIntosh 8100 computers. 4 printers, scanner, 2 data servers and complete connection to email and the internet
GIS: a complete GIS laboratory, including digitizers, work stations, ArcView, ArcInfo, and frame grabbing GIS software, GPS units, and digital video cameras
Software: Word, WordPerfect word processors, Excell and quatro-pro spreadsheets, SAS and BMDP statistical packages, Procite and Absearch bibliographic software.
Field Equipment: We are fully equipped. 3 travel trailers, flow meters, 40 recording thermisters, snorkeling gear, electrofishers, underwater cameras, 3 field vehicles, aquatic insect collecting gear, solar pathfinders and equipment to measure vertical hydraulic gradients, surveying station, boats, first aid kits, cellular phones.
University Facilities: The university provides, offices laboratories, communications, photocopying, book keeping services, and university library

g. References. (Not included in 10-page limit for this section.) Provide complete citations to all publications referred to in Sections 6a-f. List in order: author(s), date, title, report number, publisher or agency, location. References will not be read by reviewers; the substance of any reference should be described in the text and the source cited. Sample citation:

> Rondorf, D.W., and K.F. Tiffan. 1997. Identification of the spawning, rearing and migratory requirements of fall chinook salmon in the Columbia River Basin. Annual Report 1995. DOE/BP-21078-5, Bonneville Power Adminsitration, Portland, Oregon.

Armour, C.L. 1991. Guidance for evaluating and recommending temperature regimes to protect fish. U.S.D.I. Fish and Wildlife Service, Instream Flow Information Paper 27, Biological Report 90 (22).

Hanson, M.L. 1987. Riparian zones in eastern Oregon. Oregon Environmental council, Portland, OR, 74 p.

Howell, P.J. and D.V. Buchanan. 1992. Proceedings of the Gearhart Mountain bull trout workshop. Oregon Chapter of the American Fisheries Society, Corvallis, OR.

Li, H.W., G.A. Lamberti, T.N. Pearsons, C.K. Tait, J.L. Li, and J.C. Buckhouse. 1994. Cumulative effects of riparian disturbance in small streams of the John Day Basin, Oregon. Transactions of the American Fisheries Society 123:627-640.

McIntosh, B.A., J.R. Sedell, J.E. Smith, R.C. Wissmar, S.E. Clarke, G.H. Reeves, and L.A. Brown. 1994. Historical changes in fish habitat for select river basins of eastern Oregon and Washington. Northwest Science 68:36-53.

Ratliff, D.E. and P.J. Howell. 1992. The Status of bull trout populations in Oregon. Pages 10-17, *in* Howell, P.J. and D.V. Buchanan (eds.). Proceedings of the Gearhart Mountain bull trout workshop. Oregon Chapter of the American Fisheries Society, Corvallis, OR.

Tait, C.K., J.L. Li, G.A. Lamberti, T.N. Pearsons, and H.W. Li. 1994. Influences of riparian cover on benthic community structure in high desert streams. Journal of the North American Benthological Society 13(1):45-56.

Torgersen, C.E., D.M. Price, B.A. McIntosh, and H.W. Li. 1995. Thermal refugia and chinook salmon habitat in Oregon: applications of airborne thermal videography. *In* Proceedings of the 15th Biennial Workshop on Videography and Color Photography in Resource Assessment./ American Society for Photogrammetry and Remote Sensing. Department of Geography, Geology and Anthropology, Indiana State University, Terre Haute, Indiana. 167-171 pp.

Torgersen, C.E. 1996. Multiscale assessment of thermal patterns and the distribution of chinook salmon in the John Day River Basin, Oregon. M.S. Thesis. Oregon State University.

Torgersen, C.E. Submitted. Multiscale thermal refugia and stream habitat associations of chinook salmon in northeastern Oregon. Ecological Applications.

Wissmar, R.C., J.E. Smith, B.A. McIntosh, H.W. Li, G.H. Reeves and J.R. Sedell. 1994. Ecological health of river basins in forested regions of eastern Washington and Oregon. Northwest Science 68:1-35.

Section 8. Relationships to other projects

Indicate how the project complements or includes collaborative efforts with other projects; put the work into the context of other work funded under the FWP. If the proposed project requires or includes collaboration with other agencies, organizations or scientists, or any special permitting to accomplish the work, such arrangements should be fully explained. If the relationship with other proposals is unknown or is in conflict with another project, note this and explain why.

This is not intended to duplicate the Relationships table in Section 3. Instead, it allows for more detailed descriptions of relationships, includes non-interdependent relationships, and includes those not limited to specific Bonneville projects.

Our work fits well within the efforts of ODFW and NMFS to recover the depleted and endangered stock of spring chinook salmon in the Snake River Subbasin.

Section 9. Key personnel

Include names, titles, FTE/hours, and one-page resumes for key personnel (i.e. principal investigator, project manager), and describe their duties on the project. Emphasize qualifications for the proposed work. Resumes should include name, degrees earned (with school and date), certification status, current employer, current responsibilities, list of recent previous employment, a paragraph describing expertise, and up to five recent or especially relevant publications or job completions.

CURRICULUM VITAE
HIRAM W. LI

Commit 0.25 FTE to Project

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Professor and Assistant Leader
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Department of Fisheries and Wildlife
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EDUCATION:
A.B. - Zoology, University of California, Berkeley, 1966; **M.S. - Fishery and Wildlife Biology**, Colorado State University, 1973; **Ph.D.- Ecology,** University of California, Davis, 1973

EXPERIENCE:
Professor and Assistant Leader, Oregon Cooperative Fishery Unit, Department of Fisheries and Wildlife, Oregon State University. 1988-Present; **Associate Professor and Assistant Leader**, Oregon Cooperative Fishery Unit, Department of Fisheries and Wildlife, Oregon State University. 1979 to 1988; **Assistant Professor**, Department of Wildlife and Fisheries, University of California, Davis. July 1973 to January 1979.

PROFESSIONAL ACTIVITIES:
Ecology Advisory Panel for the National Science Foundation 1984-1987; **Associate Editor** for Transactions of the American Fisheries Society 1986-1988; **Foley-Hatfield Congressional Team** on Eastside Forest Health Assessment, 1992-1993; **Referee** for 14 primary journals

HONORS AND AWARDS:
Commendation Award, Sport Fishing Institute (1978); **Quality Performance Awards,** U.S. Fish and Wildlife Service (1982, 1989, 1990, 1991); **Director's Research Excellence Award**, U.S. Fish and Wildlife Service
(1991); **Special Achievement Award**, U.S. Fish and Wildlife Service (1992, 1993, 1994); **Outstanding Group Achievement Award, American Institute of Fishery Research Biologists** (awarded to the Cooperative Fish and Wildlife Research Units) (1992)

PUBLICATIONS: 30 refereed papers in Primary Journals, 10 Book Chapters, 30 Technical

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FIVE PUBLICATIONS RELATED TO THIS PROPOSAL :

Li, H.W., G.A. Lamberti, T.N. Pearsons, C.K. Tait, J.L. Li. 1994. Cumulative impact of riparian disturbance in small streams of the John Day Basin, Oregon. Transactions of the American Fisheries Society 123(4):627-640.

Bayley, P.B. and H.W. Li. 1992. Riverine Fishes. Chapter 12. Pages 251-281 in P. Calow, G.E. Petts (eds.). The Rivers Handbook, Hydrological and Ecological, Volume 1. Blackwell Scientific.

Li, H.W. , K. Currens, D. Bottom, S. Clarke, J. Dambacher, C. Frissell, P. Harris, R.M. Hughes, D. McCullough, A. McGie, K. Moore, R. Nawa, and S. Thiele.1996. Safe havens: genetic refuges and evolutionary significant units. Pages 371-380, *in* J. Nielsen (ed.), Evolution and the aquatic Ecosystem: Defining unique units in population conservation. American Fisheries Society. Bethesda MD.

Tait, C.K., J.L. Li, G.A. Lamberti, T.N. Pearsons, and H.W. Li. 1994. Relationships between riparian cover and the community structure of high desert streams. Journal of the North American Benthological Society 13(1):45-56.

Li, H.W. and J.L. Li. 1996. Fish Community Composition. Pages 391-406 *in* F.R. Hauer and G.A. Lamberti (eds). Methods in stream ecology. Academic Press, N.Y., N.Y.

Note: See above for papers and manuscripts related to remote sensing, FLIR and salmonid research.

CURRICULUM VITAE

Bruce A. McIntosh

Commit 0.25 FTE to project

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Research Associate

Department of Forest Science

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EDUCATION:

B.S. – Wildlife Biology, University of Montana, Missoula, 1982: **M.S. – Forest Ecology**, Oregon State University, Corvallis, 1992; **Ph.D. – Forest Ecology**, Oregon State University, Corvallis, 1995.

EXPERIENCE:

Research Associate, Department of Forest Science, Oregon State University. 1995 – Present; **Research Assistant**, Department of Forest Science, Oregon State University. 1992 – 1995.

FIVE PUBLICATIONS RELATED TO THIS PROPOSAL:

McIntosh, B.A. 1995. Historical changes in stream habitats in the Columbia River basin. Ph.D. dissertation. Corvallis, OR: Oregon State University. 175 pp.

McIntosh, B.A., J.R. Sedell, J.E. Smith, R.C. Wissmar, S.E. Clarke, G.H. Reeves, and L.A. Brown. 1994. Historical changes in fish habitat for select river basins of eastern Oregon and Washington. Northwest Science, 68 (Special Issue):36-53.

McIntosh, B.A., N.J. Poage, and K. Ronnenberg. 1996. Identification and mapping of stream temperatures in the Illinois River basin using forward-looking infrared technology. Final report to the Rogue Valley Council of Governments, Cave Junction, OR. 27 pp.

Torgerson, C.E., N.J. Poage, M.A. Flood, D.J. Norton, and B.A. McIntosh. 1996. Airborne thermla remote sensing of salmonid habitat for restoration planning in Pacific Northwest watersheds. In: Proceedings of Watershed 96, June 1996, Baltimore, MD. Water Environment Federation.

Karalus, R.S., M.A. Flood, B.A. McIntosh, and N.J. Poage. 1997. ETI surface water quality monitoring technologies demonstration. Final report to the Environmental Protection Agency, Characterization Division, Las Vegas, NV. 86 pp.

Section 10. Information/technology transfer

How will technology or technical information obtained from the project be distributed or otherwise implemented? Methods can include publication, holding of workshops, incorporation in agency standards or facilities, and commercialization.

We will transfer information through the following means
Refereed publications
Presentation of papers at local, regional and national scientific meetings
College of Agriculture and College of Forestry bulletins and publications
BPA publications

Congratulations!

Thank you for completing the FY99 Proposal Form. Please print and save this file to diskette, and mail both to the address shown at the top of this document. To ensure a thorough review of your proposed work, this form will be screened for completeness. If it is not complete, it may be returned to you with a request for additional information.